> supply. Erichsen fails to teach a housing ... However, Cantoni teaches a housing in Fig. 9"

The Examiner concludes that "it would be obvious to one of ordinary skill in the art to place the waveguide of Erichsen in a housing as taught by Cantoni."

Claims 33, 34 and 35 have been cancelled. The Applicants traverse the Examiner's rejections of Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 under 35 U.S.C. 103(a) relying upon Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) for the following reasons.

For an obviousness rejection to be proper, the Examiner must meet the burden of establishing a *prima facie* case of obviousness. *In re Fine*, U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988). The Examiner must meet the burden of establishing that *all* elements of the invention are disclosed in the prior art; that the prior art relied upon, coupled with knowledge generally available in the art at the time of the invention, must contain some *suggestion or incentive* that would have motivated the skilled artisan to modify a reference or combine references; and that the proposed modification of the prior art must have had a reasonable expectation of success, determined from the vantage point of the skilled artisan at the time the invention was made. *In re Fine*, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988); *In re Wilson*, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970); *Amgen v. Chugai Pharmaceuticals Co.*, 927 U.S.P.Q.2d, 1016, 1023 (Fed. Cir. 1996). Moreover, the mere fact that references *can* be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

Erichsen et al teaches a **slab** laser. (*Title, Abstract, Col. 1, l. 61, 66, Claims*). The slab laser of Erichsen et al comprises "cooled mutually parallel electrodes having a given thickness, the electrodes having flat surfaces facing each other and defining a discharge chamber therebetween..." (*Col. 1, l. 67 – Col. 2, l. 2*). Erichsen et al goes on to teach "a relatively narrow discharge chamber 5..." (*Col. 3, l. 41*). The discharge chamber is seen in Figure 1 of Erichsen et al at reference numeral 5. Erichsen et al does *not* teach, nor even suggest, as the Examiner contends, that

> "Erichsen teaches a waveguide with a plurality of rectangular channels defined between electrodes 2 and 4."

(*Office Action, pg. 2*). That statement is simply false. The discharge chamber 5 constitutes a waveguide **in one dimension** and does not contain a plurality of <u>waveguide channels formed therein and configured so as to form a pattern of folded waveguide channels intersecting at the ends thereof subtending thereby an oblique angle between adjacent waveguide channels</u> as required by Claim 1 of the application.

Still further, Erichsen et al, teaches the use of split electrodes to avoid thermal bending of the long electrodes in high power slab lasers. The electrodes are thick enough so coolant can flow through them. Since the electrodes essentially constitute a

waveguide in one dimension for the slab laser radiation, any thermal bending of the electrodes has an adverse effect on the laser's performance. All of the teachings of the patent to Erichsen et al are directed toward avoiding the bending of the slab laser electrodes in high power slab lasers having powers above 500W. The gas discharge is diffusion cooled by being in contact with the upper and lower electrodes.

The present application addresses waveguide gas lasers of several hundred watts maximum and does not address slab lasers having output powers up to and greater than 1000W. The application does not address the thermal bending issue of the thick electrodes and the adverse effect this bending has on the laser performance. The laser configuration of this application utilizes a ceramic rectangular slab into which folded waveguide channels are machined in a saw tooth pattern. Thin electrodes are placed on each side of the high dielectric constant ceramic rectangular material. The thin electrodes and the ceramic material are free to expand under thermal load in the laser design of this application. No coolant flows through the two thin electrodes. The gas discharge in this application is diffusion cooled by being in thermal contact on three sides by the folded ceramic waveguide walls and on the forth side by the thin $Ti0_2$ coated Ti electrode. Consequently, in the present application, thermal cooling problems are very much less severe than for the Erichsen et al laser design so that there is not need to split the electrodes based on thermal issues.

Applicants split the electrodes to solve the problem caused by the large capacitance generated by the high dielectric constance of the ceramic material, plus with the large surface area of the two electrodes sandwiching the ceramic rectangular slab material. Large capacitance lowers the RF impedance which makes the gas discharge very difficult to initiate with standard RF voltages. When it does initiate by applying a much higher than normal electric pulse, the large volumn of the discharge for a 200 to 300W waveguide laser further lowers the impedance which makes matching the impedance of the RF power supply into the laser gas discharge very difficult. The large circulating currents caused by the large capacitance also make the laser inefficient. These problems are not encountered in waveguide lasers having output powers of 150W or less so there is no need to split the electrodes for these lower power lasers.

In summary the present application teaches that splitting the electrodes when the capacitance of the laser structure becomes to high, increase the unlit gas laser discharge impedence which makes it easier to initiate a gas discharge. Splitting the electrodes also increases the lit impedence by reducing the gas discharge volume in direct proportion to the number of split electrodes. Ideally, the laser prefers a very high unlit impedance and a 50 ohms lit impedance for 1.) ease of in igniting the laser gas discharge, 2.) ease of maintaining a uniform discharge and 3.) ease of impedence matching the RF power into the discharge. Application 9/612, 733 teaches that splitting the electrodes aids in moving toward these ideal conditions. Erichsen et al do not address any of these issues.

Cantoni teaches a "laser resonator 47 within a waveguide gas laser system, which includes polygonal ceramic block 49, intersecting waveguides 57 formed in block 49..." (*Col. 5, l. 23 – 25*). Cantoni continues to disclose that "waveguides 57 are located at **45**

degrees and 135 degree angles relative to reflecting mirrors 59, with light reflecting ninety degrees upon each incidence with a reflecting mirror [emphasis added]." (*Col. 5, l. 44 – 47*).

Cantoni fails to teach or even suggest a "waveguide structure including a plurality of waveguide channels formed therein and configured so as to form a pattern of folded waveguide channels **intersecting at the ends thereof subtending thereby an angle between adjacent waveguide channels of less than fifteen degrees**, as required by amended Claim 1.

Yet further, Cantoni teaches the use of optical waveguides channels machined within a dielectric such as a ceramic material. The waveguides are folded at an angle of 50 degrees or more with the channels crossing each other numerous times. The present application teaches the sawtooth folding (i.e. a zig-zag) pattern of optical waveguide channels which never cross each other. The folded angle between our adjacent channels is 10 degrees or less.

Applicants have determined that at the point of waveguide channel crossings, gas discharge "hot spots" occur which adversely affects the efficiency of the laser. In addition, we have found that for large angles, as per the teaching of Cantoni, the accuracy required in positioning each of the numerous reflecting mirrors at the point where the radiation within two waveguide channels are reflected back into each other is very sensitive and small errors can greatly affect the output power of the laser. The added mirror position and alignment sensitivity for the large waveguide folding angle of Cantoni can be as much as an order of magnitude greater than for Applicant's small waveguide folding angles between adjacent intersecting waveguide. It is too difficult to manufacture the waveguide of Cantoni mainly due to the great sensitivity in positioning the numerous mirrors. Added to these disadvantages is the low efficiency of the laser due to the discharge hot spots at the numerous waveguide cross overs. The sawtooth folded waveguide configuration of the present application with small intersecting angles between adjacent waveguides greatly reduces this mirror alignment/positioning sensitivity so that it is much more manufacturable.

There is a major difference between the folded waveguide configurations of the present application and that of Figure 7 of Cantoni. The angle Θ between the waveguide channels (and thus between incident and reflected laser beams at the mirrors) of the present invention is small, i.e., about 3 degrees to about 15 degrees. Similar angles in Cantoni are much larger, i.e., anywhere from 60 degrees and larger as seen in Figures 1, 2, 3, 4, 5 and 7 thereof. However, having small angles Θ greatly relaxes the accuracy required in positioning the reflecting mirrors (140 of Fig. 10A) a distance $\underline{d_4}$ from the end of the waveguide (146). In order to allow room for positioning of the mirrors, as is normally required during the laser alignment process, the waveguide structure (146) is cut back by an amount $\underline{d_4}$. The ideal mirror position occurs when $\underline{d_4}$ is located at the point where the centerlines of adjacent channels intersect. As $\underline{d_4}$ moves away from this location, then less and less radiation is coupled from one waveguide channel into an adjacent channel. The larger the angle Θ, as in the Cantoni patent, a simple geometric

consideration reveals that there is much greater sensitivity in the positioning of the mirrors (59) in order to obtain this maximum inter-waveguide coupling and therefore, minimum losses. Such geometric considerations indicate that an order of magnitude greater mirror sensitivity is experienced when using the large angles between adjacent waveguide channels as taught by Cantoni. For the large values of θ as seen in Figure 7 of Cantoni, the mirrors 59 have to be practically in contact with the waveguide structure 49 in order to obtain low losses. This is a severe disadvantage from the point of view of mirror alignment and laser assembly.

Still further, the multiple waveguide intersections of Cantoni as seen for example in Figures 3, 4, 5 and 7 thereof, result in appreciable optical losses per intersection. This in turn results in lower laser efficiency. In addition, the fact that the area of the discharge is larger at such waveguide intersections results in a more intense gas discharge (i.e., "hot spots") at the locations of the intersections. These "hot spots" heat the gas and contribute further to lower laser efficiency. As the ratio of the number of waveguide intersections to the total waveguide lengths increases, a point of diminishing benefits rapidly occurs due to these hot spots.

Thus, the Applicants respectfully submit that the Examiner has not met the burden of establishing a *prima facie* case of obviousness in that the Examiner has not met the burden of establishing that *all* elements of the invention are disclosed in Erichsen et al and Cantoni; nor that the prior art relied upon, coupled with knowledge generally available in the art at the time of the invention contains any *suggestion or incentive* that would have motivated the skilled artisan to modify or combine Erichsen et al and Cantoni.

The Applicants further submit that the Examiner has not established that any proposed modification of Erichsen et al and Cantoni would have had a reasonable expectation of success, determined from the vantage point of the skilled artisan at the time the invention was made. Moreover, the Applicants submit that the mere fact that Erichsen et al and Cantoni *could* be combined or modified does not render the resultant combination obvious unless Erichsen et al and Cantoni also suggest the desirability of the combination. Neither Erichsen et al nor Cantoni suggests this.

Thus, Applicants submit that Claims 1 – 19, 21, 24 – 29 are non-obvious over Erichsen et al in view of Cantoni and stand in condition for allowance. Notification of that fact is respectfully requested.

Claims 30 – 32 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Justus et al. (U.S. 5,491,579).

The Examiner asserts that "Erichsen in view of Cantoni fails to teach a periscope. However, Justus teaches that it is known to use such an arrangement in the laser art."

The Applicants traverse the Examiner's rejections of Claims 30 – 32 under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Justus et al. (U.S. 5,491,579).

Claims 31 and 32 have been cancelled.

Justus et al teaches "a low f/number defocusing optical limiter." (*Col.4, l. 9; Fig. 1*).

The Examiner quotes Column 1 lines 24 – 33 of Justus which states the use a dual lens (focus and recollimating) arrangement to change the diameter of a light beam. Claim 30, as amended, recites two 45 degree mirrors to bring a laser beam, which is elliptical in shape, onto the top of the laser head assembly so that the top of the laser head assembly can be used as an optical bench for the placement of a dual lens arrangement to reshape the laser beam. In the present application, the dual lenses are used to convert the elliptically shaped laser beam into a circular beam. Justus does not teach, nor even suggest, the use of a cylindrical lens to increase the divergence of the narrow axis of the elliptical beam to match the larger divergence of the long axis of the elliptical beam so that a circular beam results.

Thus, the Applicants respectfully submit that the Examiner has also not met the burden of establishing a *prima facie* case of obviousness with respect to Claim 30, and that therefore Claim 30 is non-obvious over Erichsen et al. in view of Cantoni as applied to Claims 1 – 16, 21, 24 – 29 above, and further in view of Justus. Notification of that fact is respectfully requested.

Claim 20 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Laakmann (U.S. 4,169,251).

The Examiner asserts that "Erichsen in view of Cantoni fails to teach phase and impedance matching in a waveguide laser. However, Laakmann teaches both in column 5 lines 52 – 62 and Fig. 3. Therefore it would be obvious to one of ordinary skill in the art to modify Erichsen in view of Cantoni to include the phase and impedance matching as taught by Laakmann."

The Applicants traverse the Examiner's rejections of Claim 20 under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Laakmann (U.S. 4,169,251).

Laakmann teaches "an inductor 34 connected between one terminal of a source 28 and electrode member 10." (*Col. 3, l. 61 – 64; Fig. 1*). Such an inductor tunes out the capacitance of a RF discharge waveguide CO_2 laser. However, Laakmann fails to realize

or teach that such laser structures, when utilizing long electrodes, are long enough to act as electrical transmission lines at the RF drive frequencies used to excite the discharge. Consequently the tuning of the laser's RF structure at one location with an inductor does help to improve the efficiency of the device, but considerably more improvement can be obtained by the use of multiple spiral inductors distributed along the length of the electrodes. The use of spiral inductors distributed along the entire laser RF structure (i.e. the long electrodes which generate the gas discharge between them), as in the present application, are needed for optimum and uniform coupling of the RF energy into the discharge along the entire length of the electrode. The use of multiple inductors treats the lasers RF portion as a transmission line and insures that the gas discharge along the long optical waveguide channels receives equal voltage and is therefore uniformally ignited along the entire waveguide channel length. At the high RF frequency and electrode length used in the present invention, the electrodes are essentially a transmission line. To equalize the voltage along the entire length of the electrode, multiple spiral inductors are connected along the length of the electrode. The unique serpentine design for the distributed spiral inductors revealed in the present application has the following advantages over hand wound inductor coils: 1.) They are smaller than inductors wound by hand by forming coils of wire 2.) their fabrication consumes fewer person hours, and 3.) they are cheaper to manufacturer in mass production. The Laakmann patent fails to realize or teach any of these advantages.

Thus, the Applicants respectfully submit that the Examiner has also not met the burden of establishing a *prima facie* case of obviousness with respect to Claim 20, and that therefore Claim 20 is non-obvious over Erichsen et al. in view of Cantoni as applied to Claims 1 – 16, 21, 24 – 29 above, and further in view of Laakmann. Notification of that fact is respectfully requested.

Claims 22 and 23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Smith (U.S. 3,772,611).

The Examiner asserts that "Erichsen et al in view of Cantoni fails to teach waveguide channels designed with Fresnel numbers. However, Smith teaches this [in] his abstract. Therefore it would have been obvious to one of ordinary skill in the art to modify channels in Erichsen in view of Cantoni to be designed with Fresnel numbers as taught by Smith."

The Applicants traverse the Examiner's rejections of Claims 22 and 23 under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Smith (U.S. 3,772,611).

Smith teaches the use of capillary discharge tubes that also serve as waveguides for gas lasers with a Fresnel number less than approximately 0.5. (*Abstract; Col. 2, l. 50 – 52, l. 65 – 67*). Smith does not however teach the use of rectangular waveguide

channels with different Fresnel numbers for the width and height axis thereof. The teaching of a rectangular waveguide with the largest Fresnel number having a value smaller than about 0.35 to obtain higher power output than possible with a square or round waveguide while obtaining an acceptable mode quality for most commercial application is an important contribution made the invention in the present application for the following reasons:

- A rectangular waveguide with an optimum height and a given cross-sectional area has a superior laser beam quality than a round or square bore waveguide with the same cross-sectional area. The rectangular configuration has a greater ability to discriminate against higher order modes.

- A rectangular waveguide channel, as in the present application, having a height of optimum dimension has superior diffusion cooling capabilities than a round or square waveguide of equal cross-sectional area. This superior diffusion cooling occurs because two of the four walls of the waveguide channels are closer together than possible in a square or circular waveguide of equal cross-sectional area thereby allowing superior cooling of the discharge while the long dimension of the rectangular waveguide channel provides additional gas volume for greater laser power output. This fact is not taught by the Smith patent.

- The optimum gas operating pressure of a CO_2 laser increases as the dimensions of the waveguide channel decrease. Since the saturation intensity of the CO_2 laser scales with pressure, a rectangular waveguide channel can operate at a higher gas pressure because of the relatively small height dimension of the waveguide channel and because the cross sectional area of the waveguide channel is larger due to the horizontal dimension of the waveguide channel, thus yielding higher power output than a square or round waveguide having the same cross-sectional area.

Thus, the Applicants respectfully submit that the Examiner has also not met the burden of establishing a *prima facie* case of obviousness with respect to Claims 22 and 23, and that therefore Claims 22 and 23 are non-obvious over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29 above, and further in view of Smith (U.S. 3,772,611) and stand in condition for allowance. Notification of that fact is respectfully requested.

Claim 36 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Sukhman (U.S. 5,881,087).

The Examiner asserts that "Erichsen in view of Cantoni fails to teach an aluminum electrode. However, Sukhman teaches this in his abstract. Therefore, it would

be obvious to one of ordinary skill in the art to use in Erichsen in view of Cantoni the aluminum electrodes as taught by Sukhman."

The Applicants traverse the Examiner's rejections of Claim 36 under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Sukhman (U.S. 5,881,087).

Sukhman discloses an apparatus for allowing uniform thermal expansion of the electrodes within a gas laser tube. Sukhman relates in particular to an apparatus in which a pair of elongated, parallel, electrically insulated electrodes are supported within an elongated gas laser tube to allow sliding unconstrained longitudinal movement of the electrodes relative to the laser housing tube without torsion to accommodate uneven thermal expansion of the combination while maintaining a predetermined spaced-apart relationship of the electrode and tube. (*Col. 1, l. 1 – 15*).

Sukhman teaches:

> "Tube assembly 10 includes tube 11 which is an extruded, profiled, and finned aluminum, stainless steel or ceramic structure..."

(*Col. 4, l. 36 – 38*).

However, Sukhman does not teach, nor even suggest, a ceramic waveguide structure into which waveguide channels are machined, and which is in turn placed between two electrodes as required by amended Claim 36. Furthermore, Sukhman does not teach or suggest the rectangular waveguide channel cross sectional shape of amended Claim 36. Yet further, Sukhman does not teach or suggest waveguide channels machined into a ceramic waveguide structure and configured so as to form a pattern of folded waveguide channels intersecting at the ends thereof and subtending thereby an oblique angle between adjacent waveguide channels, as required by amended Claim 36.

Furthermore, Sukhman teaches a **slab** waveguide. (*Fig. 2*). However, the discharge of the present application is not in contact with two Aluminum electrodes that form a slab waveguide as in Sukhman. In contrast, the laser gas discharge of amended Claim 36 is bounded on three sides by the ceramic waveguide structure (i.e., the rectangular cross sectional waveguide channel) and on a fourth side by an electrode in contact with the laser gas discharge in the waveguide channels.

Thus, the Applicants respectfully submit that the Examiner has also not met the burden of establishing a *prima facie* case of obviousness with respect to Claim 36, and that therefore Claim 36 is non-obvious over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29 above, and further in view of Sukhman (U.S. 5,881,087) and stands in condition for allowance. Notification of that fact is respectfully requested.

Claims 37 and 38 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Morokawa (U.S. 5,654,782).

The Examiner asserts that "Erichsen in view of Cantoni fails to teach a titanium oxide electrode. However, Morokawa teaches this in column 7 lines 7 – 10. Therefore, it would be obvious to one of ordinary skill in the art to use in Erichsen in view of Cantoni the titanium oxice electrodes as taught by Morokawa."

The Applicants traverse the Examiner's rejections of Claims 37 and 38 under 35 U.S.C. 103(a) as being unpatentable over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29, 33, 34 and 35 above, and further in view of Morokawa (U.S. 5,654,782).

The Examiner's assertion that Morokawa teaches titanium oxide electrodes is simply wrong. In fact, Morokawa teaches the use of TiO_2 **thin films** in spatial optical modulators for modulating an optical wave surface. In particular Morokawa states:

> "Reference numerals 14 and 16 denote transparent electrodes formed on the surface of each transparent substrate, and titanium oxide, tin oxide indium oxide or their mixture is used for the transparent electrodes."

(Col. 7, l. 7 – 10).

In Morokawa, the titanium oxide (TiO_2) films have to be thin enough to be transparent to visible optical radiation illuminating the TiO_2 films. Morokawa's TiO_2 electrodes also need to be electrically conductive. The present application does not use or claim TiO_2 electrodes - it uses a Ti electrode which is covered by a native oxide, TiO_2. Furthermore, the TiO_2 of the present application need not be transparent nor electrically conductive (since RF power is applied to it and not a video electrical signal as is required in Morokawa).

In the present application, a Ti electrode in contact with the gas discharge is used instead of an Aluminum electrode because the thermal expansion coefficient of the native Aluminum oxide (Al_2O_3) is sufficently different from that of Aluminum so as to cause the Al_2O_3 to "flake" off under repeated thermal cycling which occurs due to the repeated RF pulsing of the discharge. These Al_2O_3 particles "flake-off" into the discharge and are in turn heated by the laser radiation. This in turn propels them toward the output mirror of the laser. In striking the mirror, these Al_2O_3 particles damage the mirror thereby causing the lasers output power to degenerate.

The native oxide of Ti (namely TiO_2) has a thermal expansion coefficient that is closer to the Ti electrode material. Consequently, under repeated thermal cycling which occurs by the RF pulsing the discharge at the 200W to 2000W average RF power level,

considerably less particulate "flaking" occurs which result in lasers having 20,000 hours or higher of operating life times.

Morokawa utilizes deposited TiO_2 thin-film electrodes while Applicants utilize Ti electrodes (which are **not** thin-films) that have a TiO_2 **native oxide** naturally occurring on the Ti material. The TiO_2 of the present invention does not need to be conductive while the Morokawa TiO_2 electrodes need to be conductive. Furthermore, the TiO_2 of the present application does not need to be transparent while Morokawa needs to be transparent. Also the TiO_2 of the present application acts as a dielectric able to withstand high RF power and high temperatures in a gas discharge. Yet further, Morokawa's thin-film TiO_2 electrodes need to handle only microwatts (or at the most milliwatts) of video power, not the hundreds of watts of RF power to which the Ti electrode of the present application is subjected.

Morokawa's TiO_2 electrodes do not come in contact with a gas discharge and therefore do not need to withstand the high temperatures of a gas discharge.

In summary Morokawa does not teach the solution of any of the issues which arise in the lasers described in the present application.

Thus, the Applicants respectfully submit that the Examiner has also not met the burden of establishing a *prima facie* case of obviousness with respect to Claims 37 and 38, and that therefore Claims 37 and 38 are non-obvious over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29 above, and further in view of Morokawa (U.S. 5,654,782) and stand in condition for allowance. Notification of that fact is respectfully requested.

New Claim 39 which finds support at page 7, line 18 - 22 in the Specification as filed and which depends from Claim 30 is therefore also non-obvious over Erichsen et al. (U.S. 5,600,668) in view of Cantoni (U.S. 4,815,094) as applied to Claims 1 – 16, 21, 24 – 29 above, and further in view of Justus et al. (U.S. 5,491,579) and stands in condition for allowance. Notification of that fact is respectfully requested.

Conclusion

Thus based upon the foregoing Amendments and Remarks, the Applicants respectfully submit that Claims 1 – 32, 35 – 38 and new Claim 39 are novel and non-obvious over the cited prior art and stand in condition for allowance. Notification of that fact is respectfully requested.

Care has been taken that no new matter has been introduced into this application by these Amendments. It is believed that the foregoing amendments and remarks fully comply with the Office Action.

If there are any charges with respect to this amendment, or otherwise, please charge them to Deposit Account No. **06-1130** maintained by applicants' attorneys.

Respectfully submitted,

KENNEDY, JOHN, T., et al
CANTOR COLBURN LLP
Applicants' Attorneys

By: George J. Lyman
George J. Lyman
Registration No. 44,884

Date: August 23, 2002
Address: 55 Griffin Road South, Bloomfield, CT 06002
Telephone: (860) 286-2929

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	KENNEDY, JOHN, T., et al	) Group Art Unit:) 2828
SERIAL NUMBER:	09/612,733	)) Examiner:
FILED:	July 10, 2000	) G. Inzirillo)
FOR:	HIGH POWER WAVEGUIDE LASER	)

MARKED UP VERSION OF AMENDED CLAIMS

A marked up version of amended Claim 1 is set forth below:

--1. (Amended) A standing wave laser comprising:

a housing defining a plurality of compartments therein;

a plurality of mirrors disposed within the housing defining an optical cavity;

an optical, dielectric waveguide structure disposed within the [housing] optical cavity, the waveguide structure [defining] including a plurality of waveguide channels formed therein and configured so as to form a pattern of folded optical waveguide channels intersecting at the ends thereof subtending thereby an oblique angle between adjacent waveguide channels of less than fifteen degrees, the waveguide channels having a substantially rectangular or square cross section for guiding a laser beam therealong;

a plurality of electrodes disposed within the plurality of compartments and positioned along opposite surfaces of the waveguide structure so as to enclose the

waveguide channels; wherein at least one electrode is in contact with gas discharge within the waveguide channels; and

a shield disposed between the plurality of compartments for providing electrical or radio frequency isolation of the gas discharge and the plurality of electrodes from one another.

[at least one power supply connected to the plurality of electrodes.]--

A marked up version of amended Claim 2 is set forth below:

--2. (Amended) The laser as set forth in Claim 1 [further comprising a shield disposed within the housing for electrically isolating the plurality of electrodes] wherein the shield is a radio frequency shield.--

A marked up version of amended Claim 3 is set forth below:

--3. (Amended) The laser as set forth in Claim [2] 1 wherein the shield includes a plurality of fingers extending from the shield.--

A marked up version of amended Claim 4 is set forth below:

--4. (Amended) The laser as set forth in Claim 3 wherein the waveguide structure includes a plurality of holes for receiving the fingers extending from the shield.--

A marked up version of amended Claim 5 is set forth below:

--5. (Amended) The laser as set forth in Claim [2] 1 wherein the shield is disposed a prescribed distance from the plurality of electrodes for preventing electrical arcing between the shield and the plurality of electrodes.--

A marked up version of amended Claim 6 is set forth below:

--6. (Amended) The laser as set forth in Claim [2] 1 wherein the housing includes an opening in a first surface thereof allowing passage of the shield therethrough for maintaining electrical contact between the shield and the housing.--

A marked up version of amended Claim 7 is set forth below:

--7. (Amended) The laser as set forth in Claim 1 wherein the substantially rectangular or square cross section includes at least one rounded corner.--

A marked up version of amended Claim 8 is set forth below:

--8. The laser as set forth in Claim 1 wherein the waveguide structure is disposed within the [housing] optical cavity a prescribed distance from the housing for preventing electrical arcing between the waveguide and the housing.--

A marked up version of amended Claim 9 is set forth below:

--9. (Amended) The laser as set forth in Claim 1 further comprising [at least one] a plurality of flat, spiral inductors distributed along the length of the plurality of electrodes and connected to the plurality of electrodes and to [the] a power supply for tuning out the capacitance of the plurality of electrodes obtaining thereby a uniform voltage along the length of each of the plurality of electrodes and achieving a uniform gas discharge excitation.--

A marked up version of amended Claim 10 is set forth below:

--10. (Amended) The laser as set forth in Claim 9 wherein the plurality of spiral inductors are disposed within the housing a prescribed distance from the housing for preventing electrical arcing between the inductors and the housing.--

A marked up version of amended Claim 16 is set forth below:

--16. (Amended) The laser as set forth in Claim 9 further comprising a mechanism positioned between the [at least one] plurality of spiral inductors and the laser housing providing thereby a force retaining the [at least one] plurality of spiral inductors within the plurality of compartments and an electrical connection between the [at least one] plurality of spiral inductors and the laser housing.--

A marked up version of amended Claim 20 is set forth below:

--20. (Amended) The laser as set forth in Claim [1] 9 further comprising an electrical circuit connected to the power supply and to the [at least one] plurality of spiral inductors providing thereby phase and impedance matching between the power supply, [and] the [at least one] plurality of spiral inductors, [and] the plurality of electrodes and the gas discharge within the waveguide channels.--

A marked up version of amended Claim 21 is set forth below:

--21. (Amended) A standing wave laser comprising:

a housing;

a plurality of mirrors disposed within the housing defining an optical cavity;

an optical, dielectric waveguide structure disposed within the [housing] optical cavity, the waveguide structure [defining] including a plurality of waveguide channels formed therein and configured so as to form a pattern of folded waveguide channels intersecting at the ends thereof subtending thereby an oblique angle between adjacent waveguide channels of less than fifteen degrees, the waveguide channels having a substantially rectangular cross section for guiding a laser beam therealong, the waveguide channel cross section having a prescribed width to height ratio for a prescribed total length of the plurality of waveguide channels; and

a plurality of electrodes positioned along opposite surfaces of the waveguide structure so as to enclose the waveguide channels; wherein at least one electrode is in contact with gas discharge.--

A marked up version of amended Claim 22 is set forth below:

--22. (Amended) The laser as set forth in Claim 21 wherein the prescribed width to height ratio of the waveguide channel cross section for a prescribed total length of the plurality of waveguide channels is in relation to a prescribed Fresnel number in the width direction of the waveguide channels of less than about 0.35 and a prescribed Fresnel number in the height direction of the waveguide channels of less than about 0.20 obtaining thereby good mode quality in the laser output.--

A marked up version of amended Claim 23 is set forth below:

--23. (Amended) The laser as set forth in Claim 22 wherein the prescribed Fresnel number <u>in the width direction</u> is defined by the equation:

$$N_{fw} = W^2/4\lambda L_c$$

<u>and the prescribed Fresnel number in the height direction is defined by the equation:</u>

$$\underline{N_{fH} = H^2/4\lambda L_c}$$

wherein L_c is the total length of the plurality of channels, W is the width of each <u>waveguide</u> channel, <u>H is the height of each waveguide channel</u> and λ is the wavelength of the laser.

A marked up version of amended Claim 24 is set forth below:

--24. (Amended) The laser as set forth in Claim 21 wherein the substantially rectangular <u>or square</u> cross section includes at least one rounded corner.--

A marked up version of amended Claim 25 is set forth below:

--25. (Amended) A laser comprising:

a housing;

<u>a plurality of mirrors disposed within the housing defining an optical cavity;</u>

a<u>n</u> <u>optical, dielectric</u> waveguide <u>structure</u> disposed within the [housing] <u>optical cavity</u>, the waveguide <u>structure</u> [defining] <u>including</u> a plurality of <u>waveguide</u> channels <u>formed therein and configured so as to form a pattern of folded waveguide channels intersecting at the ends thereof subtending thereby an oblique angle between adjacent waveguide channels of less than fifteen degrees, the waveguide channels</u> having a substantially rectangular cross section for guiding a laser beam <u>therealong</u>;

a plurality of electrodes positioned along opposite surfaces of the waveguide structure so as to enclose the waveguide channels; wherein at least one electrode is in contact gas laser discharge; and

an optical [housing] assembly mounted to the laser housing, the optical [housing] assembly including a plurality of compartments for retaining [a] the plurality of laser beam turning mechanisms, which laser beam turning mechanisms are adjustable in angular position with respect to the laser beam or the plurality of waveguide channels, each of the plurality of compartments extending a corresponding distance from the laser housing whereby the plurality of compartments are accessible for adjusting the plurality of laser beam turning mechanisms.--

A marked up version of amended Claim 28 is set forth below:

--28. (Amended) The laser as set forth in Claim 25 wherein the optical [housing] assembly includes:

a post;

a receptacle in the post for receiving the laser beam turning mechanisms therein;

a compression ring mounted on the post for applying a force radially towards the laser beam turning mechanisms thereby retaining the laser beam turning mechanisms in the receptacle;

a flexure mechanism connected to the post and to the optical housing; and

an adjustment mechanism engaging the post at a plurality of points for providing alignment of the laser beam turning mechanisms relative to the plurality of waveguide channels.--

A marked up version of amended Claim 29 is set forth below:

--29. (Amended) The laser as set forth in Claim 25 wherein the substantially rectangular or square cross section includes at least one rounded corner.--

A marked up version of amended Claim 30 is set forth below:

--30. (Amended) The laser as set forth in Claim 1 further comprising:

a periscope housing affixed to the laser housing for receiving the laser beam emitted from one of the plurality of channels of the waveguide structure and redirecting the laser beam[.];

wherein the periscope housing includes first and second mirrors receptive of the laser beam and each mounted at an angle of about 45 degrees relative to a longitudinal axis of the plurality of channels, the first mirror being disposed at an angle of about 90 degrees relative to the second mirror; and

a cylindrical lens receptive of the laser beam from the periscope housing for converting the divergence angle of the laser beam along a horizontal axis of the waveguide channels to match the divergence angle of the laser beam along a vertical axis of the waveguide channels thereby converting an elliptical laser beam into a circular laser beam.--

A marked up version of amended Claim 35 is set forth below:

--35. (Amended) The laser as set forth in Claim 1 wherein

a first electrode of the plurality of electrodes is positioned along a first surface of the [plurality of waveguides] waveguide structure and connected to a power supply; and

a second electrode of the plurality of electrodes is positioned along a second surface of the [plurality of waveguides] waveguide structure in contact with a gas discharge in the waveguide channels and connected to the laser housing.--

A marked up version of amended Claim 36 is set forth below:

--36. (Amended) The laser as set forth in Claim 35 wherein the first electrode comprises aluminum and the waveguide structure comprises ceramic.--